Space Weather Technical Forecast

Issued on Wednesday 6 November 2024 at 01:14 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High solar activity with further M-flares expected, and a slight chance of X-class flares. Chance of G1/Minor Storms on 06/07 Oct.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a peak flare of M4.1 at 05/1526 UTC from Ex-AR3869, which is just beyond the west limb.

There are eleven active sunspot regions visible on the solar disc, including three unnumbered regions. A new, small bipolar region has emerged in the northwest disc, to the south of AR3878. In the southeast, AR3883 has generated multiple M-class solar flares and features at least one delta spot, located in the intermediate portion of the group. Although broadly similar in size, there has been some consolidation in the leading spots. AR3878 continues to slowly decay with a more open magnetic configuration appearance. AR3886 is continuing to rotate into clearer view in the southeast disc. It is a moderately sized region with a large number of spots and slow development, but the spots occupying the intermediate portion of the group are still fairly well separated at this time. There is evidence of the continuous development of the region in the northwest. The unnumbered region continues to emerge with consolidation of the small spots in its leading portion.

A CME was observed near the east limb in association with the M3.8 flare from AR3883 on 04 Nov. Although the bulk of the ejecta appears to pass behind Earth's orbit, a faint partial halo of material (mainly shock) appears to pass the Earth-Sun line, meaning that there is an chance of a glancing impact from this feature either late 06 Nov or on 07 Nov. This event that currently carries low-moderate confidence.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE/DSCOVR were at Slightly Elevated levels throughout, generally between 420-470km/s due to minor coronal hole influence. Density was predominantly below average, but steadily increased to average by end of the period. The Interplanetary Magnetic Field (IMF), Bt, was predominantly Weak to Moderate, ranging between 7-10nT. The north-south component, Bz, varied weakly, oscillating between positive and negative directions. Phi angle was persistently positive (away from the Sun). Geomagnetic Activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 fell to background levels through the period. High energy electron flux (greater than 2MeV) observed by

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GOES16 was at background. The associated 24-hour fluence was well below the Active threshold, with 1.79e6 integrated flux observed at 06/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is forecast to continue, with occasional M-class flares expected and a slight chance of isolated X-class flares. These most likely from AR3878, AR3883 and AR3886.

Solar Wind / Geomagnetic Activity: Connection to coronal hole fast winds is ongoing, albeit weakly, with a steady decline likely on Day 1 (06 Nov). A further minor HSS enhancement is possible late Day 3 (08 Nov) into Day 4 (09 Nov).

A CME that left the Sun early on 04 Nov has been re-analysed, which may give Earth a glancing impact either on Day 1 or 2 (06 or 07 Nov) with low-moderate confidence.

Geomagnetic activity is expected to decline to mainly Quiet levels through Day 1 (06 Nov) and Day 2 (07 Nov), potentially becoming Unsettled to Active with a chance of G1/Minor Storm intervals depending on any potential CME influence. On Day 3 and 3 (08-09 Nov) activity should be Quiet to Unsettled, but with a chance of isolated Active intervals.

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 has now declined to background levels, with only a slight chance of any further enhancement above S1/Minor Storm levels. The high energy electron flux is expected to be mainly Background to Moderate, with the associated fluence forecast to persist below Active levels.

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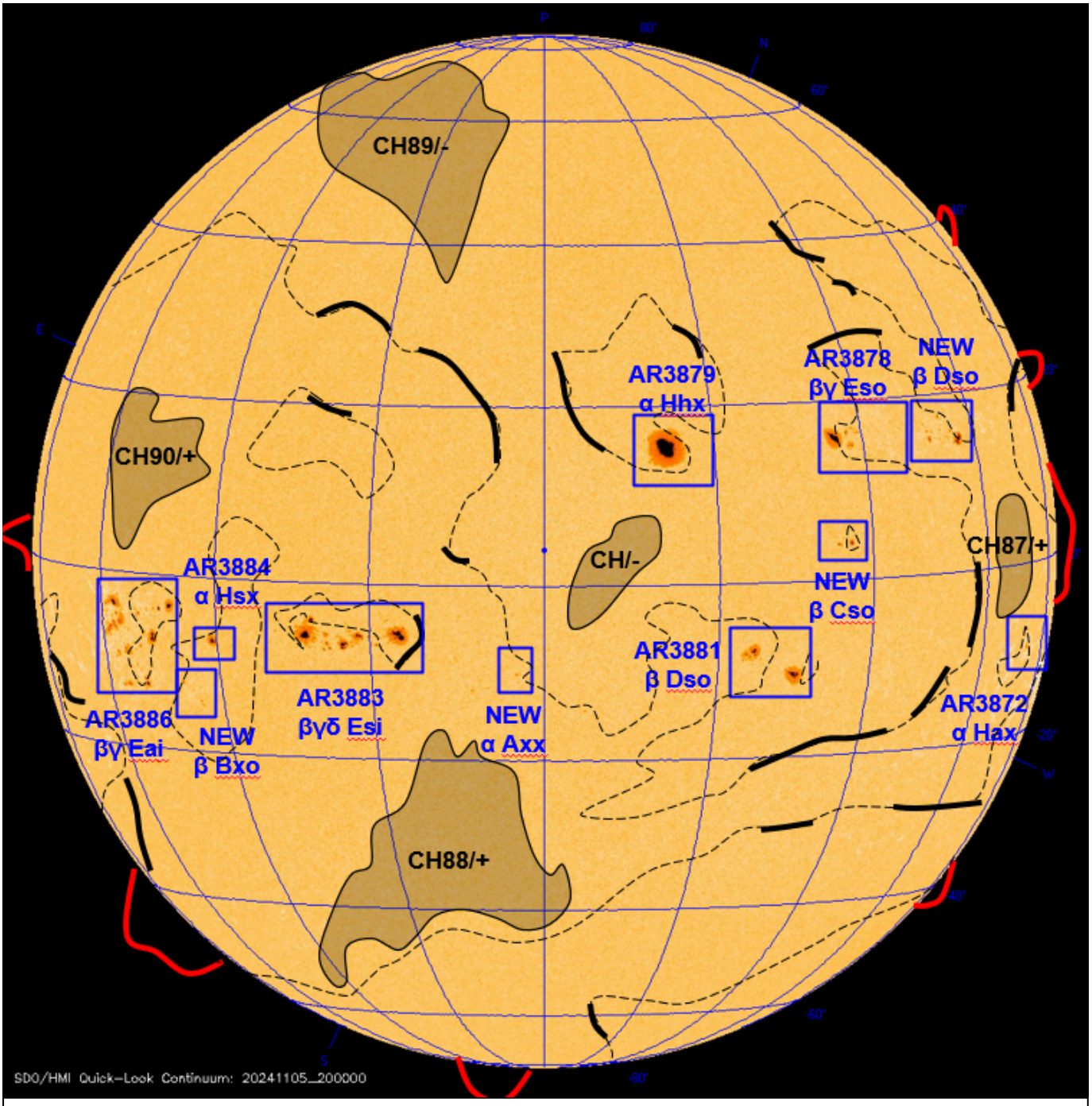
Figure 1: Solar Synoptic Map valid 05/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME was observed off the E limb in association with the M3.8 flare from AR3883 at 04/0141UTC, with an associated Type II radio emission of 307km/s. Some data gaps in coronagraph imagery have backfilled since the initial analysis was conducted by MOSWOC. Although the bulk of the ejecta appears to pass behind Earth's orbit, a faint partial halo of material (mainly shock) appears to pass the Earth-Sun line, meaning that there is an increased chance of a glancing impact from this feature either on 06 or 07 Nov than previously indicated. This event currently carries low-moderate confidence.

The near Earth environment continues to be weakly enhanced with winds currently at Slightly Elevated levels, likely as a result of a weak connection to coronal hole CH87/+, or perhaps CH86/+. An unnumbered coronal hole near centre disc may also give an enhancement in solar winds later on day 3 (08 Nov) or day 4 (09 Nov), but as this is a non-recurrent feature confidence is moderate. MOSWOC's ENLIL model shows significant speed increases from HSS influence from day 2 (07 Nov), but this appears to be unreliable.

Activity is expected to decline to mainly Quiet levels through Day 1 (06 Nov) and Day 2 (07 Nov), potentially becoming Unsettled to Active with a chance of G1/Minor Storm intervals depending on any potential CME influence. On Days 3-4 (08-09 Nov) activity should be Quiet to Unsettled, but with a chance of isolated Active intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	30	30	10	10
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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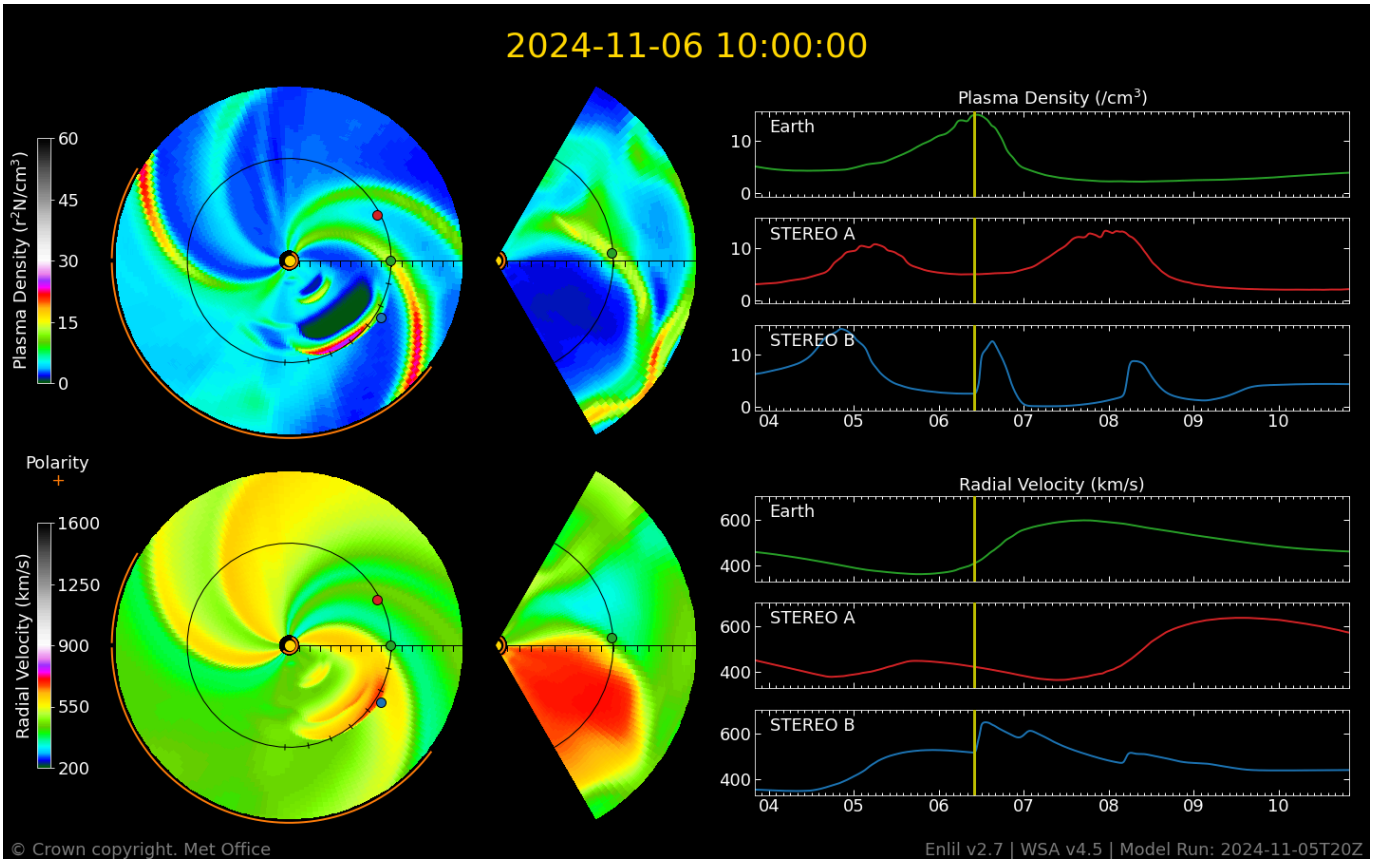
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-11-04 05:39	Partial	AR3883	SE	880	06-07 Nov	Arrival time still uncertain as CME awaiting further analysis and modelling.

Figure 2: ENLIL shows a possible glancing CME either on 06 Nov or 07 Nov.



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Radio Blackouts - X-Ray Flares

There are eleven active sunspot regions visible on the disc, including three unnumbered regions. A new, small bipolar region has emerged in the northwest disc, to the south of AR3878. In the southeast, AR3883 has generated multiple M-class solar flares and features at least one delta spot, located in the intermediate portion of the group. Although broadly similar in size, there has been some consolidation in the leading spots. AR3878 continues to slowly decay with a more open magnetic configuration appearance. AR3886 is continuing to rotate into clearer view in the southeast disc. It is a moderately sized region with a large number of spots and slow development, but the spots occupying the intermediate portion of the group are still fairly well separated at this time. There is evidence of the continuous development of the region in the northwest. The unnumbered region continues to emerge with consolidation of the small spots in its leading portion.

The cluster of spots in the southwest are approaching the limb and as such are difficult to analyse. These regions will rotate over the western horizon in the coming days. The other spots on the disc are comparatively smaller or less magnetically complex. A region at or just beyond the eastern limb produced an M2.6 flare at 05/0654 UTC. As it rotates onto the facing-disc in the coming days this could supplement existing flare probabilities and offset the loss of the regions in the southwest.

Moderate or High Solar activity is forecast to continue, with further M-class flares expected and a slight chance of isolated X-class flares, with AR3878, AR3883 and AR3886 currently the most likely source for significant flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	10	10	10	10

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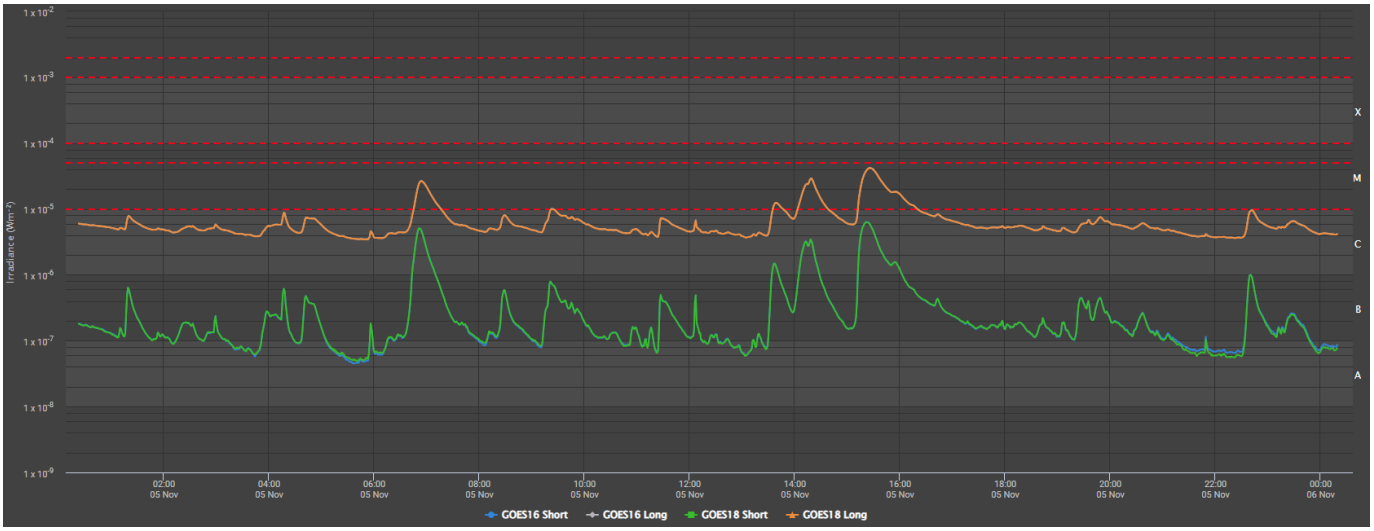
Figure 3: GOES X-Ray flux trace



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 has returned to normal background levels following recent enhancements.

Many of the sunspots that occupy the usually more geoeffective western hemisphere are smaller, less complex regions compared to those in the eastern disc, however, a number of regions recently rotated over the western horizon could still pose a small risk of an enhancement in the next couple of days.

There is a slight chance of S1/Minor Proton Storms or greater during the period should any further proton-rich flares occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	10	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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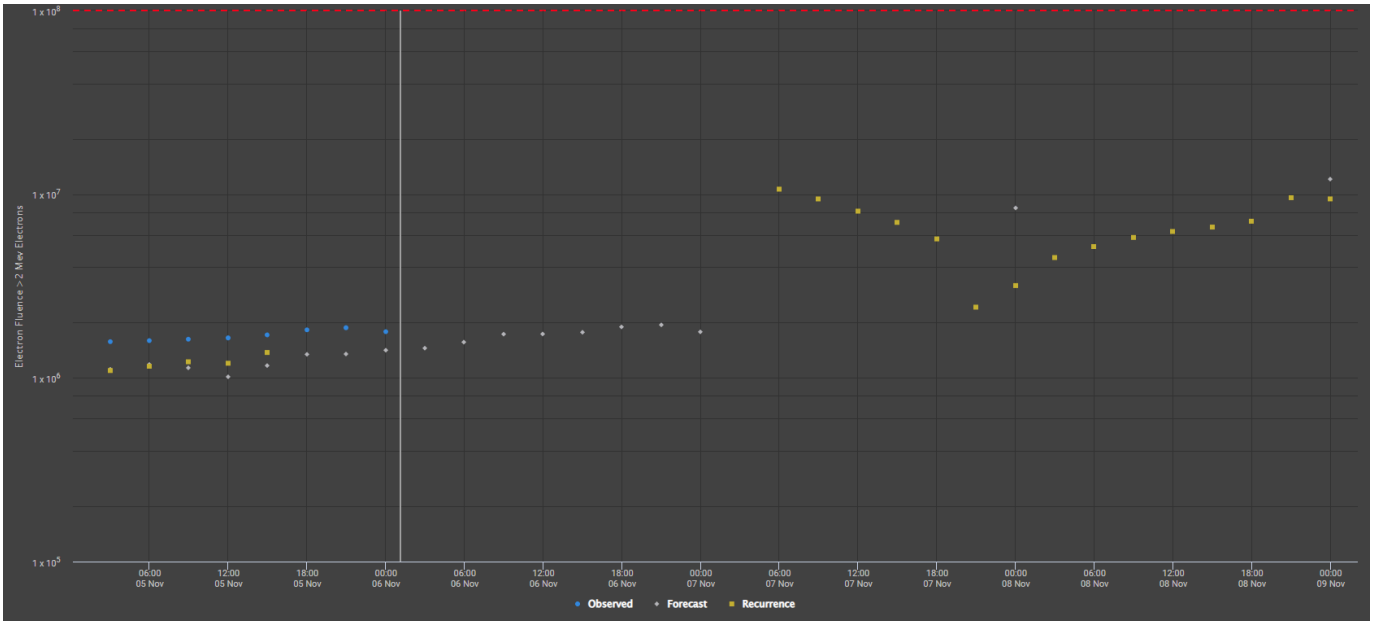
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to persist mostly at this level, with only brief periods of Moderate enhancement expected. A more significant connection to coronal hole fast winds than we are currently seeing could see the electron belts charge up over the next couple of days, with the belts then expanding later in the period, and electron flux levels rising perhaps to more Moderate to High levels.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period however, with the MOSWOC REFM forecast thought to be providing reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	5	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: MOSWOC REFM electron fluence.



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